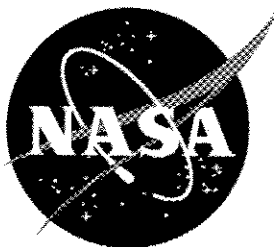


# **LIVING WITH A STAR (LWS) PROGRAM**

## **Program Plan**

462-PLAN-0005 (A)

**Effective Date: July 14, 2009**



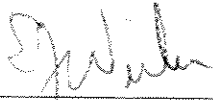
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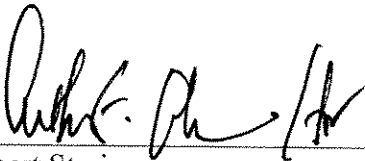
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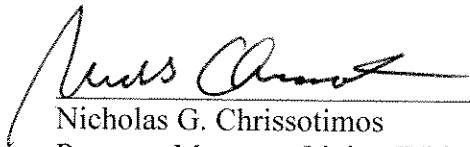
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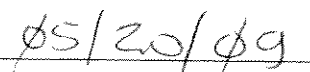
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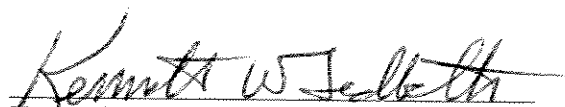
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## **PROGRAM PLAN**

### **Living With a Star (LWS) Program**

#### **1.0 PROGRAM OVERVIEW**

##### **1.1 INTRODUCTION**

Our solar system is governed by the Sun, a main-sequence star midway through its stellar life. The Sun's influence is wielded through gravity, radiation, the solar wind, and magnetic fields as they interact with the masses, fields, and atmospheres of planetary bodies. The variability of the Sun has significant impacts on life and technology that are felt here on Earth and throughout the solar system. Heliophysics is the comprehensive term for the study and exploration of the Sun, its effects on Earth and the planets of the solar system, and space environmental conditions and their evolution. The Sun and its effects on changing planetary atmospheres and operations in space are called space weather; that is, space weather is defined as the conditions on the Sun and in the solar wind, magnetosphere, ionosphere, and thermosphere that can influence the performance and reliability of space-borne and ground-based technological systems and endanger human life or health. Through the eyes of multiple spacecraft, we see our solar system as a "heliosphere," a single, interconnected system moving through interstellar space. On Earth, this interaction with our star is experienced through space weather's effects on radio and radar transmissions, electrical power grids, and spacecraft electronics, through modifications to the ozone layer, and through climate change.

The Living With a Star (LWS) program was funded starting in 2001 to develop the scientific understanding to address the aspects of the connected Sun-Earth system that affect life and society. The LWS program requirements were formulated prior to funding using a series of community workshops, results of the Space Science strategic planning process, interagency discussions, and reports by the National Space Weather Program and National Research Council/National Academy of Sciences. Participants in the formulation were from United States (U.S.) industry, universities, and government agencies.

The LWS program adopted the Pasteur mode of science -- science with utility; that is, the products from the LWS program are useful to the LWS customers -- the science, engineering, and user application communities. The LWS products impact technology associated with space systems, communications and navigation, and ground systems such as power grids. Its products that improve the understanding of the ionizing radiation environment in space have applicability to human radiation exposure in the Space Station, to high altitude aircraft flight, and to future space exploration and utilization with and without human presence. Its products impact life and society by improving the definition of solar radiation that is a forcing function for global climate change, surface warming, and ozone depletion and recovery.

The LWS requirements formed the basis for the Formulation Authorization Document (FAD) for the LWS program that was issued as a Level 0 document in July 2000. The Agency Program Management Council (PMC) confirmed the program and its first mission, Solar Dynamics Observatory (SDO), to begin implementation in June 2004.

The LWS program is a coordinated set of loosely coupled missions and science research wherein each mission has unique science but the science from one mission can support supplemental investigations in other LWS missions. The current status is as follows: the SDO project, the Radiation Belt Storm Probes (RBSP), and the Space Environment Testbeds (SET)-missions are in implementation. The Solar Orbiter Collaboration mission, and the Balloon Array for RBSP Relativistic Electron Losses (BARREL) are in formulation. The Solar Probe Plus mission is in pre-formulation. There is also a science research portion of the LWS program which is managed by the National Aeronautics and Space Administration (NASA) Headquarters (HQ) Heliophysics Division.

## 1.2 GOALS AND OBJECTIVES

The LWS program emphasizes the science necessary to understand those aspects of the Sun and space environment that affect life and society. The ultimate goal is to provide a predictive capability understanding of the system, almost to the point of predictability, of the space weather conditions at Earth as well as the interplanetary medium. LWS missions have been formulated to answer specific science questions needed to understand the linkages among the interconnected systems that impact us.

LWS program objectives are as follows:

1. Understand solar variability and its effects on the space and Earth environments with an ultimate goal of a reliable predictive capability of solar variability and response;
2. Obtain scientific knowledge relevant to mitigation or accommodation of undesirable effects of solar variability on humans and human technology on the ground and in space; and
3. Understand how solar variability affects hardware performance and operations in space.

These LWS program objectives flow down from sub-goal 3B, “understand the Sun and its effects on Earth and the solar system,” in the *2006 NASA Strategic Plan* and the *Science Plan for NASA’s Science Mission Directorate (SMD) 2007-2016*. The LWS program objectives also flowed from the precursor documents, the *NASA Strategic Plan 2003* and its applicable science roadmap, the *Sun-Earth Connection (SEC) Roadmap 2003*, which were applicable when the program was in formulation and then approved to begin implementation. An update to the SEC roadmap, *Heliophysics: The New Science of the Sun-Solar System Connection*, which aligns with the “*2006 NASA Strategic Plan*”, is a reference document.

The *Science Plan for NASA’s Science Mission Directorate 2007-2016*, the *Heliophysics roadmap (Heliophysics: The New Science of the Sun-Solar System Connection Recommended Roadmap for Science and Technology 2005-2035)* and the LWS Program Commitment Agreement (PCA) provide the linkages between LWS program components and the Heliophysics research objectives, and they are given in Table 1.2-1.

NASA Strategic Sub-goal 3B and Heliophysics Science Goal: Understand the Sun and its effects on Earth and the solar system.			
LWS Program Components	Applicability of Research Objectives for Heliophysics Science Goal to LWS Program Components		
	Understand the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium	Understand how human society, technological systems, and the habitability of planets are affected by solar variability and planetary magnetic fields	Develop the capability to predict the extreme and dynamic conditions in space in order to maximize the safety and productivity of human and robotic explorers
<b>Science Missions</b>			
SDO	M	M	S
RBSP	M	M	M
BARREL	M	M	M
Solar Orbiter Collaboration	M	S	S
Solar Probe Plus	M	S	M
Science	M	M	M
SET-I		M	

\*Key: M=Major contribution; S=Supporting contribution

Table 1.2-1. Major and supporting contributions of the LWS program components to achieving the research objectives for the Heliophysics science goal in the *Science Plan for NASA's Science Mission Directorate 2007-2016*.

The yearly Integrated Budget and Performance Document (IBPD) that is issued when the President's Budget Request (PBR) is released displays the Government Performance and Results Act (GPRA) performance and efficiency measures for the LWS missions as well as performance measures for Heliophysics science. The performance measures for the research, making progress in achieving the Heliophysics research objectives, are independently evaluated yearly by the Heliophysics Subcommittee of the NASA Advisory Council.

The performance and efficiency measures for the missions and Heliophysics in fiscal year (FY) 2009 are defined in the Integrated Budget and Performance Document (IBPD) for each FY, and examples for FY 2009 are displayed in Tables 1.2-2 and 1.2-3, respectively. Official and public documentation that the performance measures for missions are achieved, are reviewed by the NASA Heliophysics Subcommittee, collected in the NASA Performance and Accountability Report, and submitted to the Office of Management and Budget. An assessment of the efficiency measures is performed at Headquarters and documented in the Program Assessment and Rating Tool and submitted to the Office of Management and Budget.

Performance Measures for FY 2009
Launch SDO and commission spacecraft
Complete Phase B for the RBSP mission
Select instruments for the Solar Probe Plus mission
Select instruments for the Solar Orbiter Collaboration mission
Complete Phase B for the Geospace-Mission of Opportunity (BARREL)

Table 1.2-2. GPRA performance measures for LWS missions in FY 2009.



Efficiency Measures for FY 2009
Complete all development projects within 110% of the cost and schedule baseline.
Deliver at least 90% of scheduled operating hours for all operations and research facilities.
Peer-review and competitively award at least 90%, by budget, of research projects.
Reduce time within which 80% of NASA Research Announcement (NRA) research grants are awarded, from proposal due date to selection, by 5% per year, with a goal of 130 days.

Table 1.2-3. GPRA efficiency measures for LWS missions in FY 2009.

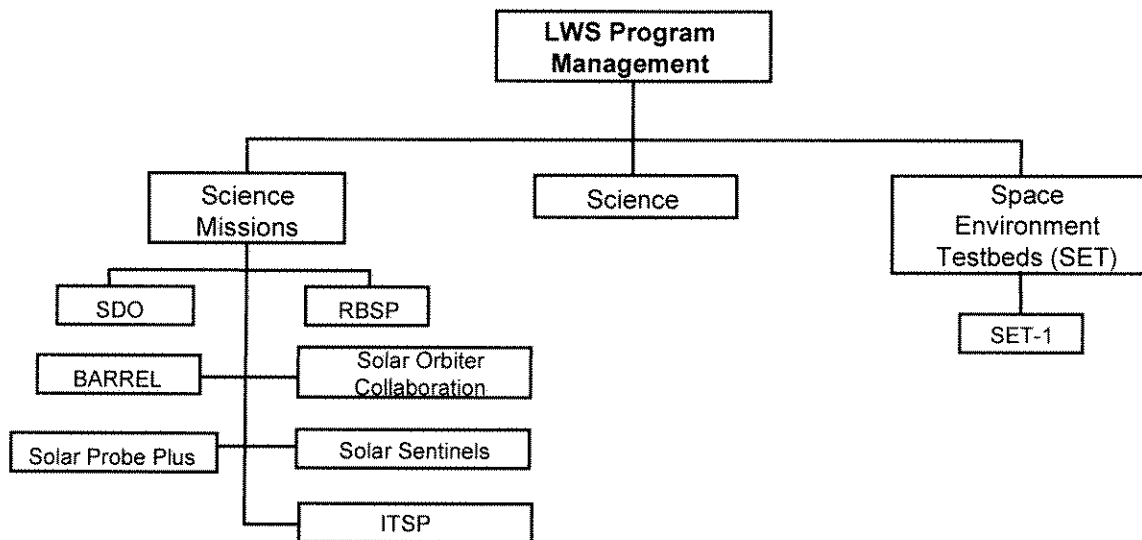
Agency-wide achievement of performance and efficiency measures is documented in the Performance and Accountability Report that is available at [http://www.nasa.gov/offices/ocfo/budget/Par\\_detail.html](http://www.nasa.gov/offices/ocfo/budget/Par_detail.html).

Safety and mission success requirements are found in the NASA Policy Directive 8700.1E, NASA Policy for Safety and Mission Success, and this policy is applicable to LWS and its missions.

### 1.3 PROGRAM ARCHITECTURE

The LWS program is a loosely coupled program of synergistic missions aimed at meeting the program objectives wherein each mission has unique science capability, which supports supplemental investigations in other LWS missions. The LWS program uses a three-pronged systems approach to implement its objectives:

1. Perform mission-unique science and also replace or complement measurements from other heliophysics spacecraft using several new LWS research spacecraft. The combined measurements from LWS and other heliophysics spacecraft to obtain sets of near-simultaneous measurements that are strategically placed to address large-scale "system" heliophysics science problems. These combined measurements will be used to develop new scientific understanding of the physics, dynamics, and behavior of the Sun-Earth connected system through the range of conditions occurring during solar cycles.
2. Improve knowledge of space environmental conditions and variations over the solar cycle, develop new techniques and models for predicting solar/geospace disturbances, and develop cost-effective techniques for assimilating data from networks of spacecraft using products from basics and applied research investigations funded from LWS Science.
3. Perform investigations using existing data and using new data from a low-cost SET mission to reduce the uncertainty in the definition of the space environment in the presence of a spacecraft (i.e., the induced environment) as functions of location and time in the solar cycle and to minimize or accommodate space weather effects on space hardware.



**Figure 1.3. Elements of the LWS program.**

Science missions and SET are managed in accordance with the NPD 7120.4 and NASA Procedural Requirements (NPR) 7120.5. Science and BARREL are managed using a Basic and Applied Research process in accordance with NPR 7120.8. Science uses peer-reviewed competitions from Headquarters; its requirements are derived using inputs and reviews from the Heliophysics science community through the LWS Steering Committee.

The LWS program relates to other organizations both inside and outside of NASA through its projects. These organizations include the Science Operations Mission Directorate (SOMD) for launch vehicles, Office of External Relations for agreements with international partners, industrial suppliers, Department of Defense (DoD), Federal Funded Research and Development Centers, University Affiliated Research Centers (UARC's) and University instrument and investigation providers through contracts.

The project-specific requirements appendices, i.e., Program Level Requirements Appendices (PLRA), attached to this LWS Program Plan define relationships with external organizations.

The NASA Strategic Goal, Sub-goal, Research Objectives, and Research Focus Areas align with the missions identified in Table 1.2-1 and provide the basis for the NASA SMD determination of the sequence and content of additional missions in the LWS program. These mission priorities and rationales are described in the SMD Summary of the *Science Plan for NASA's Science Mission Directorate 2007-2016*.

## **1.4 STAKEHOLDER DEFINITION**

The science community and NASA SMD are the immediate customers of the Living With a Star program. The NASA HQ Heliophysics Division provides the program with its operating budget, programmatic guidelines, and identification of the scientific goals and objectives. The Heliophysics science community is the principal user of the data resulting from the selected mission and provides the intellectual advice and rationale for the measurements.

Customers of the results from the LWS program are: the Heliophysics science community; NASA mission operations; the national operational space weather community led by the National Oceanic and Atmospheric Administration and DoD; other operational agencies of the U.S. government; commercial, and other government agencies that operate spacecraft.

The HQ Heliophysics Division engages stakeholder communities to ensure advocacy through a variety of venues, such as, the Heliophysics Subcommittee of the NASA Advisory Council (NAC), the American Geophysical Union, the National Academies of Science and its Space Studies Board, and the Committee for Solar and Space Physics.

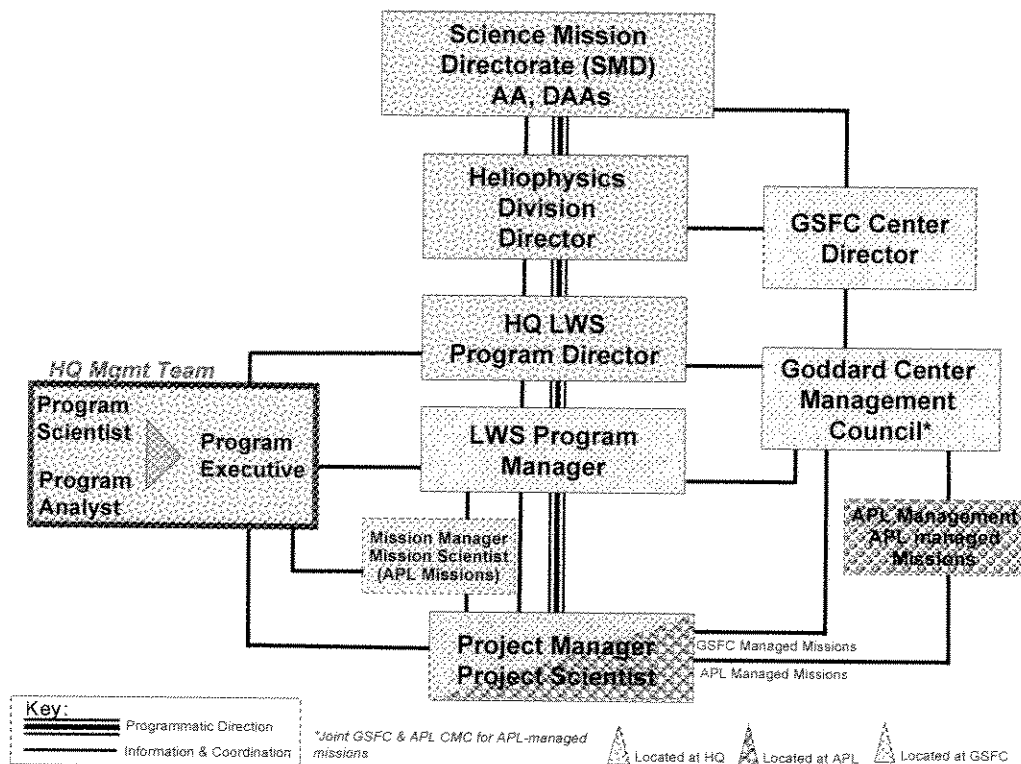
## **1.5 PROGRAM AUTHORITY, MANAGEMENT APPROACH, AND GOVERNANCE STRUCTURE**

SMD and the LWS program follow NPD 7120.4, *Program/Project Management* and NPR 7120.5, *NASA Program and Project Management Processes and Requirements* for both program and flight project management. Projects are formulated, approved, and terminated in accordance with these procedures. SMD implements these procedures through the processes described in the NASA Headquarters SMD Management Handbook. If there is a conflict, the NPR is the guiding document. However, the NPR ascribes Directorate responsibilities only to the SMD Associate Administrator (AA) and does not acknowledge the SMD AA's supporting organization, which actually implements the majority of the functions assigned to the SMD AA. The SMD Management Handbook clarifies these delegated responsibilities.

The LWS program is a loosely coupled program. The Goddard Space Flight Center (GSFC) has been designated as the implementing Center for the program. The SMD AA has delegated flight program authority and responsibility through Division Directors to the Program Managers at the field centers. LWS program direction flows from the Heliophysics Division Director (DD) through a HQ Program Director to the LWS Program Manager at GSFC and then to the Project Manager. The HQ Heliophysics Program Director is the Heliophysics Deputy DD. The governing PMC for the LWS program is the Agency PMC.

The GSFC Center Director is responsible for establishing, developing, and maintaining the institutional capabilities (processes and procedures, human capital, facilities, and infrastructure) required for the execution of the LWS program, including the system of checks and balances to ensure the technical integrity of programs and projects assigned to the Center.

The LWS program consists of projects that are managed by either GSFC or the Johns Hopkins University/Applied Physics Laboratory (JHU/APL). GSFC and JHU/APL have developed a Memorandum of Agreement defining management relationships between GSFC and APL.



**Figure 1.5-1. SMD Mission Management Accountability**

Figure 1.5-1, “SMD Management Accountability,” shows the lines of authority for SMD management accountability of programs and projects. Figure 1.5-1 also shows lines of programmatic coordination.

The SMD AA delegates responsibilities to the Program Executive (PE) through the DD. The PE serves as the DD’s technical arm to keep track of programmatic activities and ensure the project is initiated and executed according to approved processes. The PE acts as the primary interface for the DD with the Program and Project Managers at GSFC or other implementing organizations, maintaining a current knowledge of project status.

The LWS program has a lead Program Scientist (PS), and a Program Scientist assigned to each project. The LWS lead PS administers the Science segment of the LWS program and, in support of the Heliophysics DD, provides a science interface and integrating function between the Heliophysics science community, the heliophysics advisory subcommittees, the international science community, and the space weather community. The Science segment is administered by awarding grants from solicited proposals for this purpose in the yearly Research Opportunities in Earth and Space Sciences (ROSES) NRA using advice from the LWS Targeted Research and Technology (TR&T) Steering Committee (see <http://lws-trt.gsfc.nasa.gov>). The primary forums to accomplish these integrating activities are the International LWS (ILWS) Steering Committee (see <http://ilws.gsfc.nasa.gov>) to work cooperatively with the international science community and the Committee on Space Weather to coordinate with other government agencies under the umbrella of the Federal Coordinator for Meteorology (see <http://www.nswp.gov>).

For each project, its PS is the senior NASA scientist responsible for a flight program or project's science content to carry out an SMD science investigation. The PS is SMD's interface with the Project Scientist or the Principal Investigator (PI) for an Announcement of Opportunity (AO)-selected mission. The PS monitors science management and NASA Headquarters program execution and ensures the science of the mission remains viable and true to strategic objectives during development of the mission. The PS is the steward of the Level-1 science requirements and maintains regular communications with the PE. Both participate fully in decisions and meetings relevant to mission planning and implementation.

The Program Analyst (PA) retains information on each project's New Obligation Authority and budget plan, oversees the annual Planning, Programming and Budgeting Execution process, and serves as the primary point of contact to generate and maintain the IBPD for Directorate programs.

The HQ PE, PS, and PA management team maintains close contact with program and project personnel to keep abreast of project status. PEs, PSs, and PAs are not in the direct line of authority. The Heliophysics DD, Deputy DD, or the SMD AA signs letters of direction to the program and projects. When necessary, the program office may send letters of direction to the projects.

Program-level requirements for a multi-project program such as LWS are documented in the body of the Program Plan. For LWS projects, the requirements are attached to the LWS Program Plan as project-specific requirements appendices, referred to as either PLRA or Level-1 Requirements. The PE generates this material through coordination with the PS, the Program Manager, the PI (as applicable) and/or the Project Scientist, the Mission Manager and Project Manager. Program-level requirements in either a Program Plan section or appendix, should be baselined under configuration control by the Heliophysics Division Director at the beginning of a project's Phase B and signed off by the Mission Directorate Associate Administrator before Phase B ends.

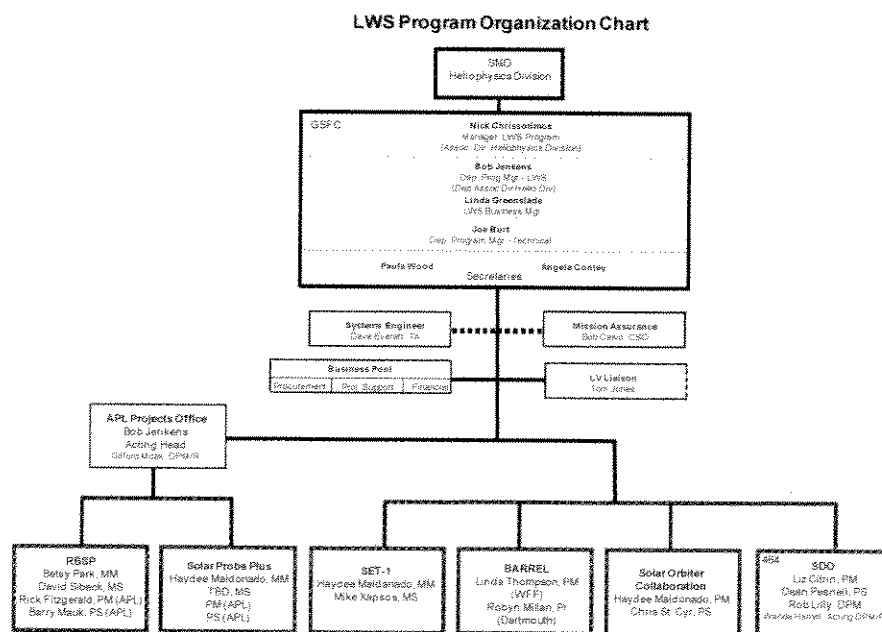


Figure 1.5-2. LWS Program Organization Chart.

The PLRA (Level-1 Requirements) shall be approved by the same signatories who approve the Program Plan, since the PLRA is an extension of that Plan. These signatories are the SMD AA, the Center Director, and the Program Manager. In addition, the Heliophysics DD, PE, PS, Project Manager, Project Scientist, and SMD Chief Engineer shall sign in concurrence. The necessary signatures and concurrences must be obtained prior to Confirmation.

**Program Office** - The LWS program office at GSFC is the prime interface to NASA HQ and has all of the authorities, responsibilities, and accountabilities defined in NPR 7120.5D. The LWS program office is the prime interface with the project office. The program office will report to the Goddard Center Management Council (CMC), Mission Directorate PMC, and Agency PMC as required.

The LWS Program Manager is the senior program official in the program office at GSFC and, according to NPD 1000.0, reports to the SMD AA at NASA Headquarters for all program related activity. Since the SMD AA has delegated day-to day oversight to DDs, the LWS Program Manager reports to the Heliophysics DD. The Program Manager implements SMD policy and guidelines and interfaces with the Heliophysics DD, Program Director, and/or PE on program cost, schedule, and technical scope. LWS Project Managers for GSFC-led projects and Mission Managers for projects not led by GSFC report to the LWS Program Manager and interface routinely with PE's.

The LWS Program Manager shall be responsible for the oversight of all LWS missions. The program office shall develop the integrated budget requirements and recommendations for SMD, based on SMD budget guidelines that are prepared coincident with the release of the President's Budget Request and the IBPD for the upcoming FY. The program office establishes operational policies for the LWS program, assures appropriate independent review of the projects in accordance with NPR 7120.5D, monitors the progress of each project, reports project and program status to GSFC and SMD management, recommends necessary corrective and preventative actions, and facilitates access to GSFC and other NASA expertise in support of the missions when requested. The technical staff will generally be matrixed to the program with little or no dedicated discipline engineering. Risk driven identification of technical areas may require deeper insight and closer tracking by the program office staff. Additional resources may be applied if necessary. The program office staff will approve movement and tracking of finances and support contract actions in accordance with HQ direction.

The Program Manager shall be responsible for tracking program metrics and reporting status to NASA Headquarters. Program management oversight and Technical Authority (TA) responsibilities will include regular communications with the Project Manager. Program staff will attend periodic and lower level reviews at the implementing organization as appropriate. Program and project office Monthly Status Reviews (MSRs) will be presented to the CMC and SMD.

To support the life cycle review process, a center Chief Engineer or equivalent will be an ex-officio member of the standing review board (SRB) for NASA Space Flight Program and Project Requirements NPR 7120.5D project reviews. Staff will also attend and /or participate in selected lower level life cycle reviews. The Program Manager will approve

the comprehensive project Review Plan. For NASA-led missions, GSFC shall make the initial recommendation of the SRB Chair and suggested key members for HQ approval. For non-NASA led missions, the implementing organization and GSFC shall make a combined initial recommendation of the SRB Chair and the suggested key members for HQ approval. The implementing organization leads the reviews below the SRB level with TA and program organization participation. The Project Manager will report out results and significant actions and coordinate with the SRB per the project Review Plan and in coordination with the program office and the HQ PE. The SRB will conduct its reviews and pre-brief cognizant parties.

For GSFC-led missions or those missions outside NASA, TA resides at GSFC.

The program office is responsible for recommending launch readiness to NASA HQ.

**Project Office** - The project office is responsible for developing and delivering the mission within cost and schedule commitments while meeting all Level 1 Requirements. Typical responsibilities include project and business management, science implementation, engineering, and safety and mission assurance. The project office has all of the authorities, responsibilities, and accountabilities defined in NPR 7120.5D to execute the mission, subject to limitations resulting from NASA's fiduciary obligations under the Federal Acquisition Regulation (FAR) and any applicable mission unique requirements or restrictions defined in the FAD. Requirements flow from this LWS Program Plan to the project offices. The baseline implementation approach for executing a project, including any mission specific tailoring, will be explicitly defined in the individual mission's Project Plan. The project office contingencies (reserves) for cost and schedule, technical descope options, and technical resource margins will be the responsibility of and managed by the project office. The project office will report to their organization CMC, the program office, the program office CMC, SMD PMC, and the Agency PMC as required. The project office host organization (APL or GSFC) is responsible for signoff/commitment for launch readiness at the launch site.

### **APL Mission Management**

A GSFC Mission Manager will be assigned that will function as the Program Manager's day-to-day point of contact for each APL managed project, performing technical and programmatic management functions on behalf of the Program Manager and ensuring the Program Manager maintains an awareness of the project status. In addition a GSFC Mission Scientist will be assigned that will address science related aspects of the mission.

## **1.6 IMPLEMENTATION APPROACH**

The LWS program office shall implement the program consistent with the latest PCA, NPR 7120.5 and HQ direction. Individual projects will be implemented per NPR 7120.5 or NPR 7120.8, as applicable. SMD approves the Program Plan which describes how the program office proposes to manage and implement the program, and holds the program manager accountable. The PLRA (Level-1 Requirements) are developed and controlled by SMD and are included as an appendix to the Program Plan. LWS projects shall use the PLRA to generate lower level requirements for implementation. NASA HQ uses these requirements to evaluate the project's performance during implementation.

Individual mission implementation is defined by each project in the Project Plan and approved by the program office and SMD. The Project Plan identifies the use of industry, UARC, or Center In-House capability. Major project element make-or-buy and trade studies are conducted at the project level to support an SMD decision. Each project develops its acquisition strategy in accordance with NASA and Center Procurement Processes to ensure cost, schedule, technical, and risk performance with appropriate insight/oversight and the use of appropriate contractual vehicles including Cost Plus Incentive Fee, Cost Plus Award Fee, etc. Partners contributing elements to a project are project-unique and their provisions are controlled by project or NASA HQ Agreements (in the case of international partnerships).

## **2.0 PROGRAM BASELINE**

### **2.1 REQUIREMENTS BASELINE**

#### **2.1.1 Program Requirements**

- a. The LWS program shall implement missions selected by NASA HQ/SMD that are defined using advice from the strategic planning and roadmap processes. Through the annual budgeting process, NASA HQ/SMD will attempt to provide a continuous line of funding for each mission that it selects.
- b. A Science and Technology Definition Team (STDT) shall be used to recommend to HQ/SMD the scope and technical performance for each selected project.
- c. A FAD issued by HQ/SMD for each selected project shall constitute the authorization to begin formulation.
- d. The AO process shall be used to select science investigations that include science instruments, sensors, and/or instrument suites and may or may not include the scope of the science defined in the STDT report.
- e. The selected science investigations and the mission requirements for a project shall define the project science and technical performance requirements.
- f. Launch vehicles used for LWS missions shall be proven vehicles consistent with the payload class defined in NPR 8705.4, Risk Classification for NASA Payloads.
- g. International partnerships for space flight hardware and software shall be conducted under formal agreements and shall provide for no exchange of funds.
- h. Each science investigation team shall maintain a data archive of its instrument science and science data products for the life of the prime mission.
- i. Each science investigation team shall provide the data obtained as part of the mission, including the engineering data and ancillary information and analysis software necessary to validate and calibrate the science data, to the public within three months after collection following the completion of post-launch checkout of the spacecraft and instruments.



- j. Each science investigation team shall deliver the data archive from the prime mission to NASA for a deep data archive within one year of the completion of the prime mission.
- k. Each science investigation team shall perform scientific analyses required for the science goals of the mission.

### **2.1.2 Requirements Documentation**

LWS program requirements for specific LWS projects are documented in the Level 1 Requirements Appendices to this Program Plan.

### **2.1.3 Program Requirements on Projects**

Level 1 Requirements Appendices to the LWS Program Plan shall be signed by the approving authorities during Phase B, prior to the Confirmation Review (CR). The core of the Approval subprocess within SMD is called Confirmation, a term used by SMD to reflect SMD's approval to go forward. For projects where the SMD PMC is governing, the CR is the gate for the Key Decision Point (KDP)-C approval. For programs and Category-1 projects, (and selected Category-2 projects) the CR is followed by an Agency PMC meeting, which becomes the KDP-C gate. The governing PMC shall always conduct the KDP meeting.

Compliance verification and traceability of the requirements that flow down from the program to the projects shall be conducted as part of the KDP reviews.

Requirements and changes to program-level requirements shall require approval of the Program Manager, SMD AA, and the GSFC Center Director and the concurrence of the Heliophysics Division Director

Missions shall have no proprietary data analysis periods, but shall release mission data as soon as possible after a brief validation period.

A requirements traceability and verification matrix as defined in the Safety and Mission Assurance Plan shall be used to confirm that the mission system has met all requirements and is ready for launch.

Project Scientist appointments shall be approved by SMD. The SMD AA has delegated that authority to the SMD DDs.

The SMD AA exercises the NPR 7120.5D option for directorate approval of LWS Project Plans and delegates this responsibility to the Director of the Heliophysics Division. Therefore, the Heliophysics DD shall review and concur on all Project Plans.

### **2.1.4 Mission Classification and Life-Cycle Costs**

Table 2.1.4-1 below defines the LWS Mission Categorization, the governing PMC and the Risk Classification. The program level requirements including cost limits and launch dates for the missions are set forth by SMD in the Program Plan Appendices (Level-1

Requirements). Table 2.1.4-2 shows key milestones and life cycle cost (LCC) for existing missions as identified in the 2009 PBR.

Program or Project/TA	Category	Governing PMC	Risk Classification
LWS Program/GSFC	N/A	Agency	N/A
SDO/GSFC	2	Mission Directorate	B
SET-1/GSFC	3	Mission Directorate	D
RBSP/GSFC	2	Mission Directorate	C
BARREL/GSFC	N/A	Mission Directorate	N/A
Solar Orbiter Collaboration/GSFC	2	Mission Directorate	C
Solar Probe Plus/GSFC	TBD	TBD	TBD
Solar Sentinels/GSFC	TBD	TBD	TBD
ITSP/GSFC	TBD	TBD	TBD

**Table 2.1.4-1: Program/Project Categorization, Governing PMC, Risk Classification**

Table 2.1.4-2 defines the key dates and time frames for the phase transitions for each project based upon the latest LWS program master schedule dated March 2009. Dates and costs for projects in formulation are guidelines for planning purposes and are subject to change as the LWS program matures.

Project	Start Formulation	MDR/PNAR*	Start Implementation	Ready for Launch**	Start Prime Operations	End Prime Operations**	LCC for Prime Mission (\$M)
<b>Projects in Implementation</b>							
SDO	8/2002	4/2003	7/2004	10/2009	12/2009	12/2014	844
SET-1	5/2003	11/2003	5/2005	8/2008	9/2012	9/2013	21
RBSP	1/2007	10/2007	1/2009	5/2012	8/2012	8/2014	688
BARREL	9/2006	5/2008	10/2008	12/2012	12/2012	3/2014	11
<b>Project in Formulation</b>							
Solar Orbiter Collaboration	6/2008	TBD	TBD	TBD	TBD	TBD	TBD

\*Mission Definition Review (MDR)/Preliminary Non-Advocate Review (PNAR)

\*\*The date for end of the prime mission assumes launch on the Launch Readiness Date as a primary payload. However, the SET-1 project is a secondary payload; therefore, the launch readiness date defines the date that the secondary payload is shipped to the host spacecraft for integration with the host spacecraft, and the date for the end of the prime mission will depend upon the launch date for the host spacecraft. The BARREL project is a balloon payload. The launch readiness date defines the date of the first launch

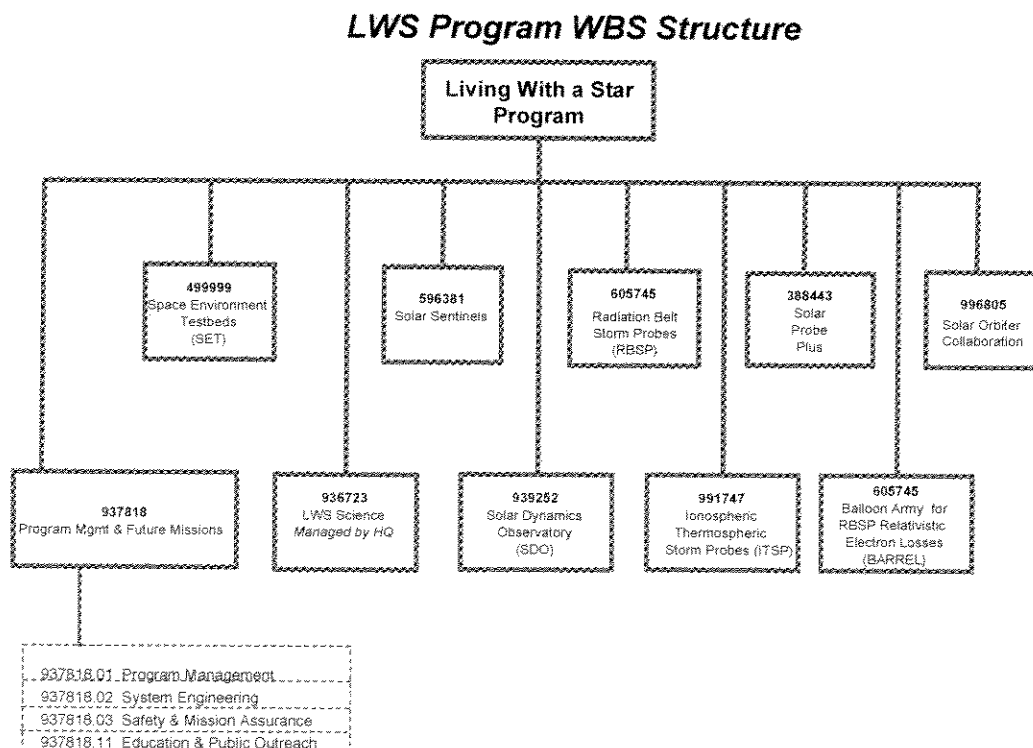
campaign, and the date for the end of the prime mission refers to the end of operations after the final launch campaign.

**Table 2.1.4-2. Key dates or target dates and time frames for the phase transitions for each project based upon the latest LWS program master schedule dated March 2009. This table will not be maintained in this document.**

Life-cycle cost constraints for LWS projects are identified in appendices. The agency budget database (N2) identifies budget constraints, by fiscal year, for the LWS program and each project, as described in Section 2.4. Constraints are validated during the yearly budget cycle and as required throughout the fiscal year. See Section 2.4, Table 2.4-1, for yearly budget constraints for projects in the implementation phase and yearly estimates for all other LWS program/project elements

## 2.2 WBS BASELINE

The LWS program Work Breakdown Structure (WBS) is depicted in Figure 2-2. As a loosely coupled program, each major program element or project is funded by a unique project structure number. The LWS program management and future missions element is depicted at level 2 and is executed by the LWS program office. All other elements or projects are shown at level 1 only, as the detailed WBS and WBS dictionaries are developed and controlled at the project level.



**Figure 2-2. LWS Program Work Breakdown Structure (WBS)**

The level 2 WBS dictionary for the LWS program management and future missions element is shown below. Project WBS's are established and maintained by the project office.

#### 937818 LWS Program Management and Future Missions

937818.01 Program Management: The business and administrative planning, organizing, directing, coordinating, analyzing, controlling, and approving processes used to accomplish overall program objectives, program level reviews, and reports to the Center and Agency management. The effort includes LWS program management, program office general support, configuration management, scheduling, information technology services, housing cost, center assessments, independent review funding for the LWS program and its projects, and funding for the Heliophysics Science Support Office, which is managed and directed by the HQ SMD Heliophysics Division. Includes labor, travel, procurements, and other direct cost.

937818.02 System Engineering: The technical and management efforts of directing and controlling an integrated engineering effort for the program as well as TA. This element includes efforts for defining technical objectives, conducting trade studies, and overseeing mission engineering, integrated planning and control of technical program efforts of design engineering, software engineering, specialty engineering, system architecture development and integrated test planning, system requirements writing, configuration control, and technical. This includes risk management to assure monitoring of the technical program and accomplishment of LWS program goals. Includes labor, procurements, and other direct cost.

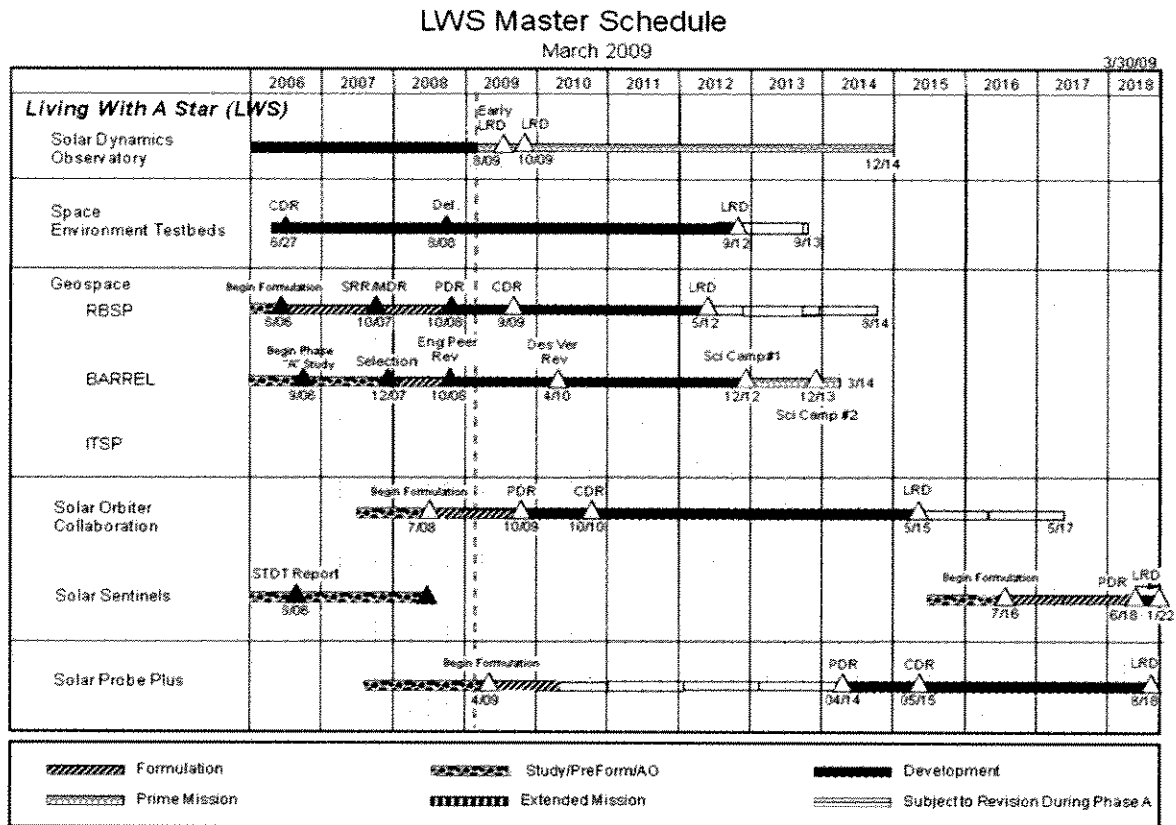
937818.03 Safety and Mission Assurance: The technical and management efforts of directing and controlling the safety and mission assurance elements of the program as well as TA. This element includes design, development, review, and verification of practices and procedures and mission success criteria intended to assure projects meet performance requirements and function for their intended lifetimes. Includes labor, procurements and other direct cost.

937818.11 Education & Public Outreach: The technical and management efforts of providing the education and public outreach (EPO) responsibilities of the program as directed by HQ/SMD/HD. Includes management and coordinated activities, formal education, informal education, public outreach, and media support. Includes labor, travel, procurements, and other direct cost. (LWS program level EPO funding was eliminated after FY2006.)

### **2.3 SCHEDULE BASELINE**

As a loosely coupled program, the LWS master schedule provides a summary of major project milestones only; the mission order is specified by SMD and driven primarily by the availability of funds. Individual project schedules are integrated and controlled by the respective projects in accordance with the project schedule management plan, as flowed

down through the LWS program schedule management plan. The LWS program master schedule, as of March 2009, is depicted in Figure 2-3.



**Figure 2.3. LWS Program Master Schedule as of March 2009. This chart will not be maintained in this document.**

## **2.4 RESOURCE BASELINE**

Table 2.4-1 identifies the current LWS program resource (or workforce) baseline that coincides with Figure 2.3. Table 2.4-2 identifies the current LWS program yearly workforce requirements associated with FY09 PBR. These workforce requirements were generated in February 2008; LWS program office requirements are based on the shared infrastructure approach identified below.

The LWS program utilizes a shared infrastructure to accomplish program level requirements. The Explorers and Heliophysics Projects Division at Goddard Space Flight Center encompasses the Solar Probe Plus, LWS, and Explorers programs. Staff, Information Technology (IT) infrastructure, and other routine resources are shared across the programs to any extent possible, in order to maintain efficiency and consistency across the Division. Other than routine office space, there are no facilities requirements at the program level. Infrastructure requirements for LWS projects, including acquisition, renovations, property/facilities, personal property, and information technology resources are identified in the individual Project Plans.

**LIVING WITH A STAR (LWS) PROGRAM BUDGET  
BY PROJECT/ELEMENT, FY09 PRESIDENT'S BUDGET**  
(\$ in millions)

	PY	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	Budget to Completion	Total
<b>Total Living with a Star</b>	<b>\$716.5</b>	<b>\$188.6</b>	<b>\$224.2</b>	<b>\$223.8</b>	<b>\$212.0</b>	<b>\$216.6</b>	<b>\$232.8</b>	<b>\$237.5</b>	<b>\$2,316.6</b>	<b>\$4,568.7</b>
Ionospheric-Thermospheric Storm Probes (ITSP) (991747)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	255.2	255.2
Solar Orbiter Collaboration (996805)	0.0	0.0	1.0	4.6	8.7	19.6	55.7	70.1	82.3	242.0
Solar Probe Plus (388443)	0.0	0.0	13.9	0.0	3.4	40.1	74.2	106.3	482.3	720.1
Geospace Mission of Opportunity (270989)	2.8	1.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	4.1
BARREL (296527)	0.0	0.0	0.8	0.9	3.9	2.4	2.0	2.1	0.0	12.1
Solar Sentinels (596381)	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	1,476.0	1,478.5
Radiation Belt Storm Probes (RBSP) (605745)	35.0	12.9	67.8	154.4	154.7	113.4	57.9	15.8	12.2	624.2
LWS Space Environment Testbeds (499999)	28.8	3.6	3.1	0.7	0.7	0.0	0.0	0.0	0.0	36.8
LWS Science (936723)	91.7	17.7	18.8	22.9	21.4	22.2	22.8	23.7	0.0	241.1
LWS Program Mgmt & Future Missions (937818)	77.2	5.0	6.7	16.2	5.1	5.0	5.3	5.4	0.0	125.8
Solar Dynamics Observatory (SDO) (939252)	465.7	144.0	108.1	24.1	14.2	14.0	14.9	14.1	8.6	807.6
Living With a Star Management (783550) (HQ)	2.2	1.8	4.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0
Solar Probe (844209)	13.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.1

NOTE: PY adjusted to reflect Program/Project actuals; FY08 reflects FY08 initial op plan

**Table 2.4-1. LWS Program/Projects Funding. This chart will not be maintained.**

**LIVING WITH A STAR (LWS) PROGRAM  
CIVIL SERVANT (FTEs) and CONTRACTOR (WYEs) WORK FORCE  
AS OF 2/08**

	FY2007	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014
<b>Total Living with a Star</b>	<b>FTEs</b>	<b>132</b>	<b>100</b>	<b>47</b>	<b>26</b>	<b>27</b>	<b>26</b>	<b>29</b>
	<b>WYEs</b>	<b>109</b>	<b>127</b>	<b>26</b>	<b>13</b>	<b>23</b>	<b>20</b>	<b>8</b>
	<b>Total</b>	<b>241</b>	<b>227</b>	<b>73</b>	<b>39</b>	<b>50</b>	<b>46</b>	<b>37</b>
<b>Ionospheric-Thermospheric Storm Probes (ITSP) (991747)</b>	<b>FTEs</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>
	<b>WYEs</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	<b>Total</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>
<b>LWS Forecast Labor (335673) (FTEs reserved for Solar Orbiter &amp; Solar Probe)</b>	<b>FTEs</b>	<b>0</b>	<b>2</b>	<b>7</b>	<b>9</b>	<b>9</b>	<b>11</b>	<b>15</b>
	<b>WYEs</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>
	<b>Total</b>	<b>0</b>	<b>2</b>	<b>7</b>	<b>10</b>	<b>10</b>	<b>12</b>	<b>16</b>
<b>Solar Orbiter Collaboration (996805) (TBD)</b>	<b>FTEs</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	<b>WYEs</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	<b>Total</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>Solar Probe Plus (388443) (TBD--assume RBSP might approach)</b>	<b>FTEs</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	<b>WYEs</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	<b>Total</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>BARREL (296527) (selection 12/07; Wallops rqrmts not included)</b>	<b>FTEs</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	<b>WYEs</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	<b>Total</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>Solar Sentinels (596381)</b>	<b>FTEs</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>
	<b>WYEs</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>
	<b>Total</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>
<b>Radiation Belt Storm Probes (RBSP) (605745) (FY11/12 increase for use of GSFC I&amp;T facilities)</b>	<b>FTEs</b>	<b>8</b>	<b>5</b>	<b>6</b>	<b>5</b>	<b>8</b>	<b>5</b>	<b>1</b>
	<b>WYEs</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>11</b>	<b>8</b>	<b>1</b>
	<b>Total</b>	<b>8</b>	<b>6</b>	<b>7</b>	<b>6</b>	<b>19</b>	<b>13</b>	<b>2</b>
<b>LWS Space Environment Testbeds (499999)</b>	<b>FTEs</b>	<b>9</b>	<b>6</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>
	<b>WYEs</b>	<b>11</b>	<b>9</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>
	<b>Total</b>	<b>20</b>	<b>15</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>0</b>	<b>0</b>
<b>LWS Science (936723)</b>	<b>FTEs</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>3</b>
	<b>WYEs</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>2</b>
	<b>Total</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>5</b>
<b>LWS Program Mgmt &amp; Future Missions (937818)</b>	<b>FTEs</b>	<b>8</b>	<b>8</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>5</b>
	<b>WYEs</b>	<b>12</b>	<b>11</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>
	<b>Total</b>	<b>20</b>	<b>19</b>	<b>7</b>	<b>7</b>	<b>7</b>	<b>8</b>	<b>8</b>
<b>Solar Dynamics Observatory (SDO) (939252)</b>	<b>FTEs</b>	<b>101</b>	<b>75</b>	<b>25</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>2</b>
	<b>WYEs</b>	<b>83</b>	<b>104</b>	<b>20</b>	<b>6</b>	<b>6</b>	<b>0</b>	<b>0</b>
	<b>Total</b>	<b>184</b>	<b>179</b>	<b>45</b>	<b>9</b>	<b>8</b>	<b>8</b>	<b>2</b>

**Table 2.4-2. LWS Program/Project Office Work Force. This chart will not be maintained.**



### **3.0 PROGRAM CONTROL PLANS**

#### **3.1 TECHNICAL, SCHEDULE, AND COST CONTROL PLAN**

Monthly technical, schedule, and cost information is collected, analyzed, acted upon, and reported to GSFC's CMC, SMD, and agency Budget and Performance Report to assure that all project and program requirements are being met with adequate reserves. The LWS Program and/or Project Manager and their team shall conduct Project Reviews, Failure Review Boards, Configuration Control Board (CCB), and schedule and cost reviews. Risk management shall be applied following the guidelines of Goddard Procedural Requirement (GPR) 7120.4A, Risk Management Procedural Requirements. The minimum set of Risk Management tools that shall be used are schedule, technical, and financial reserves, risk mitigation starting early in the program, Probabilistic Risk Assessment, Failure Modes and Effects Analysis, Fault Tree Analysis, engineering models, and use of descope options.

Technical status for each mission shall be tracked via requirements shown in the Level 1 to Level 4 Requirements Traceability and Test Verification matrices. Tracking shall follow processes and requirements specified in the project Safety and Mission Assurance Requirements document as well as the project's Systems Engineering Management Plan and Risk Management Plan. Design margins shall be established and the reserves tracked and reported.

Schedule management for the LWS program and projects will be implemented in accordance with the LWS Schedule Management Plan (462-PLAN-0001B). Integrated master schedules shall be generated for all projects of the LWS program using automated scheduling tools and appropriate schedule management methodology that shows both baseline and current schedule data. They shall identify the project critical path for management and control and ensure that schedules contain all critical milestones for internal and external activities, time durations for activities, schedule reserves or slack, and interdependencies.

Cost control shall incorporate monthly tracking metrics such as reserve status, liens and encumbrances, reserve percentage of cost to go, obligations and cost – plan vs. actual forecast, and labor – plan vs. actual forecast. The project shall be responsible for implementing a system that meets NASA requirements as stated in NPR 7120.5 for a cost, schedule and milestone tracking system that provides sufficiently detailed data to adequately and quantitatively assess the current progress of the mission on a monthly basis, and provide a forecast for accomplishing work to be completed within the remaining established cost and schedule parameters. Schedule and cost status shall be provided as part of the monthly project review process.

Earned Value Management is not implemented at the program level. Each project shall implement an Earned Value Management process in accordance with current NASA policies, NPR 7120.5D requirements, and consistent with their center/organization best practices to control costs. Costs and schedules shall be tracked against baseline

projections and shall be reviewed monthly to ensure that performance is closely monitored and appropriate actions taken if necessary.

### **3.2 SAFETY AND MISSION ASSURANCE (SMA) PLAN**

The LWS program office shall be responsible for ensuring that LWS projects develop approved Safety and Mission Assurance (SMA) plans and implement those plans. The SMA Standards of the project host organization shall be used when the project office resides in that organization. In addition, the project office shall address the SMA requirements of the NASA procurement vehicle (e.g., AO, etc.) and obtain concurrence with the LWS program office for any waivers to these requirements.

Project requirements flow from the NASA and GSFC safety and mission assurance requirements and may be tailored and/or expanded for the specific mission. Each project shall develop safety and mission assurance plans that meet current requirements and reflect a project life-cycle process perspective, addressing areas including: procurement, management, design & engineering, design verification & test, software design, software verification & test, manufacturing, manufacturing verification & test, operations, and pre-flight verification & test.

In addition, the project office will coordinate with the NASA Independent Verification & Validation (IV&V) Facility if independent software IV&V is being performed for the mission.

For GSFC-managed projects, the program will utilize the existing Nonconformance Report (NCS)/Corrective Action System database and the Problem Report/Problem Failure Report database for the Closed Loop Problem Reporting and Resolution System. Projects that are not hosted at GSFC will utilize their existing problem reporting system which will feed into the GSFC system.

### **3.3 RISK MANAGEMENT PLAN**

LWS has established a Program Level Risk Management Plan (462-PLAN-0004A). The program's risk management approach is described in the Risk Management Plan in accordance with the requirements of NPR 7120.5D and NPR 8000.4 Risk Management Procedural Requirements. The plan governs how technical, cost, schedule, and other forms of risk will be identified, analyzed, tracked, controlled, communicated, and documented to increase the likelihood of achieving program/project goals. The goal of risk management on the LWS program is to identify risks and mitigations necessary to avoid occurrence or realization of the risks. Program level risk board meetings are conducted on a regular basis. The Program Manager or Deputy chairs the risk board meetings. The Risk Board evaluates the risks for the cost, schedule, performance, and probability of occurrence and effectiveness of the mitigation. The program office reviews each project's significant risks monthly. These risks are then presented at the MSR conducted by the GSFC CMC.

The LWS program office manages program level risks that affect more than one project via the LWS program risk board as described in the LWS Risk Management Plan. In accordance with these requirements, every LWS project will establish a Risk Management Plan that identifies the cost, schedule, and technical risks within the project and methods to accommodate or mitigate them. Details of the project's risk management approach will be described in its Risk Management Plan in accordance with the requirements of NPR 7120.5D, NPR 8000.4 Risk Management Procedural Requirements, and the LWS Program Risk Management Plan.

Reliance on other government agencies or international partners that provide components to LWS projects is a moderate risk, since NASA cannot control the policy, technical performance, and schedule associated with the external commitments. To minimize this risk, the SMD seeks to conclude an explicit and timely agreement that establishes the overall policy for each partnership.

### **3.4 ACQUISITION PLAN**

There are no major acquisitions at the program level. The program office supports HQ in the identification of new missions and the conduct of the Acquisitions Strategy Meeting (ASM). All major acquisitions are performed at the project level. Each project's acquisition strategy and processes shall be fully described in its LWS Project Plan in accordance with NPR 7120.5D. Science investigations will be provided by SMD-selected PI's through AO's or an international or interagency partner under an approved agreement. In the acquisition of scientific instruments, spacecraft, and science investigations (including Research and Analysis), NASA will use full and open competitions to the greatest extent possible. Certain instruments, missions, or mission systems may be acquired without competition (e.g., through international partnerships or in-house builds) provided that there is a clear scientific, technological, or programmatic benefit to NASA to do so. Such arrangements shall be approved by the AA for SMD. The project manages the implementation of these investigations. Spacecraft may be provided through industry, in-house by a NASA Field Center, designated UARC, or an international partner under an approved agreement. SMD retains make-or-buy decision authority for all spacecraft. Launch vehicles will be acquired through existing contracts managed by the SOMD except when provided by an international partner or another organization under an approved agreement or when the LWS mission is not a primary payload on the launch vehicle. In the latter case, arrangements for access to space will be made on a case-by-case basis and documented using agreements. Acquisitions for operations services shall be consistent with NASA policy. The project will utilize established host organization processes and procedures in accordance with NPR 7120.5D.

For GSFC managed projects, the Project Acquisition Plan is developed by the Project Manager, supported by the GSFC Office of Procurement and shall be consistent with the results of the Acquisition Strategy Planning meeting and the ASM. It documents an integrated acquisition strategy that enables the project to meet its mission objectives, provides the best value to NASA, and complies with the FAR and the NASA FAR Supplement. The Acquisition Plan addresses all the required topics listed in FAR Part 1807.105 and 1807.106 and NFS Part 1807.105.

Projects shall describe completed or planned studies supporting project level make-or-buy decisions, considering NASA's in-house capabilities and the maintenance of NASA's core competencies, as well as cost and best overall value to NASA. For each science mission, the Heliophysics Division Director may charter a Science and Technology Definition Team before the start of formulation to provide advice including prioritized science requirements and to identify a pre-concept that satisfies the science requirements constraints and technology development requirements for the project. These requirements may form the basis for an AO for the acquisition of scientific investigations that include science instruments.

An LWS Steering Committee is a chartered working group of scientists that is tasked to develop requirements for LWS Science (reference charter at TR&T web site (<http://lws-trt.gsfc.nasa.gov/>)). This advice forms the basis for solicitations for fundamental research investigations in the yearly NRA, "ROSES." Requirements for investigations for the SET were derived from workshops dedicated to that purpose and were the basis for NRAs that solicited investigations and partnerships that include investigations. No follow-on SET investigations beyond the SET-I mission will be funded.

There are no program level agreements in place. Projects will describe all agreements, memoranda of understanding, barter, in-kind contributions, and other arrangements for collaborative and/or cooperative relationships in the Project Plans. Partnerships created through mechanisms other than those prescribed in the FAR will be identified in the Level I requirements for each project. All such agreements (the configuration control numbers and the date signed, or projected dates of approval) necessary for project success will be listed. In addition, all agreements concluded with the concurrence of the Program Manager will be included and referenced. The project will support NASA HQ to establish international and interagency memoranda of understanding and letters of agreement regarding provisions of investigations, spacecraft and spacecraft subsystems, launch and network services, mission operations, ground data processing and distribution, and science data as appropriate.

Contractor incentives for strengthening safety and mission assurance and risk-based acquisition management are addressed in individual Project Plans.

When external (non-LWS) agreements are needed and made, their documentation is part of the project-specific requirements appendix to the LWS Program Plan.

### **3.5 TECHNOLOGY DEVELOPMENT PLAN**

The SMD has decided to include all technology development within project lines instead of having separate technology development plans and programs. Accordingly, each project shall provide a Technology Development Plan as required that includes the content tailored for the project as specified in Appendix E, paragraph 3.5 in NPR 7120.5D.

### **3.6 SYSTEMS ENGINEERING MANAGEMENT PLAN (SEMP)**

LWS is a loosely coupled program and, therefore, each project within LWS shall have a project System Engineering Management Plan (SEMP). The LWS Program Systems Engineer ensures that the project SEMP's meet the requirements defined in NPR 7123.

The test, validation, and verification requirements for hardware and software are mission unique and shall be addressed separately in the SEMP and/or Project Plan for each project. The individual plans shall also address software independent verification and validation.

The LWS Program Systems Engineer shall monitor the technical progress of all LWS projects and shall conduct periodic meetings with all of the Project Systems Engineers to facilitate and encourage dialogue and knowledge sharing across the projects. He or she identifies or conducts trades studies for areas that span multiple projects to encourage risk or cost reduction for the program

### **3.7 REVIEW PLAN**

#### **3.7.1 Program Reviews**

The LWS program office shall support reviews consistent with NPR 7120.5D. A program level Status Review and Program Implementation Review will be conducted biennially by a Standing Review Board. This review will consider all aspects of the LWS program and the flow down to individual projects. The LWS program office will support monthly reviews with the CMC at the GSFC MSR that assess technical, schedule, and financial performance for each project and the program.

#### **3.7.2 Program Review of Projects**

The LWS program shall conduct reviews on a periodic and as-required basis to assess project progress, evaluate risk, ensure compliance, and address issues. These reviews may include, but are not limited to, Monthly Project Reviews, Independent Reviews, and weekly informal tag-ups. Monthly Project Reviews shall assess technical, schedule, and cost status, and shall include accomplishments, issues, risks, resources status (e.g., mass, power, schedule reserve, cost reserve), schedule changes, and cost variance analysis.

The project shall baseline a review plan that supports the formulation and implementation of each mission or project. Additionally, the review plan shall identify peer reviews and other reviews in accordance with host Center standards and practices, program review requirements, and the requirements in NPR 7123.1, *NASA Systems Engineering Processes and Requirements*.

### 3.7.3 Review Processes for the Project Office

The project office shall ensure that the review process, as specified in the Review Plan and applicable project host organization directives, is followed and supported. GPR 8700.4F, Integrated Independent Reviews, defines the purpose of each review. The following sets of reviews shall be included in the project's Review Plan:

1. Project KDP Reviews, conducted by a SRB, as defined in NPR7120.5D shall be defined in the Project Plan.

These formal reviews will be convened by the applicable technical and programmatic authorities. The SRB will report out to the project office, LWS program office, the Project Office Management Council as applicable, the GSFC CMC, and the Science Mission Directorate and Agency PMC's consistent with the mission project classification per 7120.5D.

2. Engineering Peer Reviews - A comprehensive set of engineering peer reviews will be established by the organization that is the provider of the engineering product. Participants will be selected by the project office host organization and are independent of the development activity under review. Every effort will be made to include technical experts from, or recommended by, GSFC. The results of the review will be reported to the LWS program office.
3. Anomaly Reviews - Review Boards for anomalies that have an unknown cause and represent significant programmatic or technical risk, shall be held and will be independent of the project and established by the project office host organization's Safety and Mission Assurance Office and Chief Engineer with applicable membership from the LWS program office's supporting TA.
4. Management Reviews - The project office host organization shall conduct regular status reviews and provide reports to the SMD Weekly Reporting System (as required by SMD), monthly and/or quarterly status reviews. The project office will provide/present an overall project assessment in the key areas of technical, schedule, cost and management including significant progress; concerns/issues (including resolution plans/expected outcomes); contingency/reserves and liens status; and all significant risk threats to the implementation or mission success. The LWS program office shall have a standing seat in the project office host organization's monthly senior status review process. A summary of the project's status shall be provided to the LWS program office in support of the program's monthly review process. The project office will present to the GSFC CMC on an as needed basis.
5. Assessment Reviews – The project office host organization will convene, when necessary, assessment reviews to evaluate the readiness of the project to execute a mission critical event, e.g., launch, encounter, etc., or to assess the design risk of a pending implementation. Representatives of the LWS program office and HQ can also participate in these reviews.

### **3.7.4 Termination and Cancellation Review Criteria**

#### Mission Termination

Within SMD, mission termination refers to the decommissioning of a mission. It is the process for ending a project that has conducted part of or its entire prime mission and which may have completed one or more extended missions. This is different than mission cancellation which refers to ending project activity before the mission is launched.

There are two means within SMD that can lead to mission termination:

- The first is through a programmatic path, such as the outcome of a Senior Review or a significant budget reduction.
- The second is as a result of a condition on the spacecraft, which may be an unexpected on-orbit anomaly, or the exhausting of consumable resources.

#### Mission Cancellation

During Implementation, each project will develop the mission within the established performance, schedule, and cost requirements identified in the PLRA (Level 1 document)

If at any time during development the Program Manager or the PE believes that the project is unable to achieve the PLRA (Level 1) requirements, or that the project development cost is anticipated to exceed the baseline by either the Congressional 15 percent or 30 percent limit, or the schedule has slipped by more than 6 months, they must notify the DD, who initiates a management notification process.

A Cancellation Review is not required if the SMD AA agrees to change the requirements or if the project is able to demonstrate that cost growth is above and beyond their control or if they can descope the mission concept or design in order to stay within the technical, cost, and schedule constraints. If none of these occurs, then it is appropriate to recommend a Cancellation Review.

If SMD decides a Cancellation Review is in order, the NASA Associate Administrator and the NASA Chief Engineer must be notified before the Center is contacted.

If a Cancellation Review is required, the program and the project teams present status and any material requested by the Decision Authority. A Center assessment is presented as the Technical Authority at the program or project level. An independent assessment review will be commissioned by the Decision Authority and following its completion, the governing PMC will hold the Cancellation Review.

### **3.8 MISSION OPERATIONS PLAN**

There is no LWS program level Mission Operations Plan since the program is a set of loosely coupled missions which each have dedicated mission operations plans. The LWS projects shall prepare Mission Operations Plans utilizing established host Center/Institutional processes and procedures in accordance with NPR 7120.5D. The Mission Operations Plan will be reviewed at the Mission Critical Design Review. It will be baselined in Phase D and reviewed at the Mission Operations Review.

### **3.9 ENVIRONMENTAL MANAGEMENT PLAN**

The LWS program and projects shall comply with NPR 8580.1, *Implementing the National Environmental Policy Act and Executive Order 12114*. There is no program specific Environmental Management Plan as the requirement is flowed to the LWS project offices. Each LWS project office shall prepare an Environmental Management Plan utilizing GPD-8715.1B *GODDARD SPACE FLIGHT CENTER SAFETY POLICY*, GPR-1700.1- *OCCUPATIONAL SAFETY PROGRAM AT GSFC* and other applicable Center documents or equivalent Institutional requirements at JHU/APL.

The LWS program office shall support the project offices in the development of this plan. Products and processes having environmental issues shall be identified at the earliest possible time during formulation to ensure that planning and decisions reflect environmental values, to avoid delays later in the process, and to head off potential conflicts. Project Environmental Data Management Plans shall be submitted to the LWS program office for approval.

### **3.10 LOGISTICS PLAN**

The logistics requirements are identified by each project in their individual Project Plans. There is no program level Logistics Plan. The LWS project offices shall each prepare logistics plans utilizing established Center/Institutional processes and procedures in accordance with the Project Plan requirements in NPR 7120.5D and NPD 7500.1B Program and Project Logistics Policy.

### **3.11 SCIENCE DATA MANAGEMENT PLAN**

There is no LWS program level Science Data Management Plan as the requirement is flowed down to the LWS projects. LWS project offices shall develop a draft project Data Management Plan by Preliminary Design Review in accordance with *NASA Heliophysics Science Data Management Policy* (dated June 25, 2007) (<http://lwsde.gsfc.nasa.gov/HPDP.html>) to address the total activity associated with the flow of science data, from acquisition, through processing, data product generation and validation, to archiving and preservation. The data management plan shall be formally approved no later than the project office's Critical Design Review. Science analysis software development, utilization, and ownership shall be covered in the Data Management Plan.



It is NASA policy that all data taken by NASA's space flight mission programs shall be publicly archived as soon as they can be properly validated and calibrated. NASA's science AOs require that this activity be budgeted in proposals. All data collected through the LWS program are to be placed in the public domain at the earliest possible time following their validation and calibration. Exceptions are on a mission-by-mission basis. Data preparation shall be accomplished within a few months from the time that NASA delivers the data to the investigation team. One exception is data that may be released almost immediately for public relations purposes.

The LWS program adherence to all NASA sample handling, curation and planetary protection directives and rules, including NPR 8020.12C, *Planetary Protection Provisions for Robotic Extraterrestrial Missions*, is not required as there are no LWS missions currently envisioned requiring planetary protection.

### **3.12 INFORMATION AND CONFIGURATION MANAGEMENT PLAN**

The LWS program has a stand-alone configuration management plan, 461-PG-1410.2.1C, LWS Configuration Management Procedure. This procedure defines the Configuration Management (CM) requirements for the LWS program and projects to meet the requirements of NPR 7123.1 and GSFC GPR 1410.2C, Configuration Management.

The LWS CM system uses CCBs at both the program and project levels. This allows for CM to be handled at the most appropriate level within the organization. For each organization level, types of configured items have been assigned for configuration management. The LWS program CCB is chaired by the LWS Program Manager or designee, who has overall responsibility for all LWS program and project office activities.

The LWS CM Procedure describes the structure of the CM organization and tools used. It describes the methods and procedures to be used for configuration identification, configuration control, interface management, configuration traceability, and configuration status accounting and communications. It also describes how CM will be audited.

The CM procedure addresses configuration management requirements for document configuration control only. Configuration Control for products is not required at the program office level but shall be addressed as necessary in project office CM procedures.

The LWS CM procedure does not apply to LWS directives posted in the Goddard Directives Management System. These directives are controlled using the procedures described in GPR 1410.1.

The LWS program shall follow the information management and knowledge capture requirements in NPD 2200.1, *Management of NASA Scientific and Technical Information*, NPR 2200.2B, *Requirements for Documentation, Approval, and*

*Dissemination of NASA Scientific and Technical Information*, NPD 1440.6, *NASA Records Management*, and NPR 1441.1, *Records Retention Schedules*.

The LWS project or mission manager shall be responsible for determining lessons learned and entering them into the NASA database after launch in accordance with NPR 7120.6 (Lessons Learned Process).

### **3.13 SECURITY PLAN**

#### **3.13.1 Security Requirements**

The LWS program methodology for ensuring security and technology protection will utilize established procedures in the GPR documents with the assistance of the GSFC Facilities Division and GSFC Security Division. GSFC maintains Building Emergency plans (700-SFTY-0001). The programs approach to implementing IT security requirements shall be accordance with GPR 2810.1. The content of these plans addresses the Emergency Notification System, Types of Emergency Situations, Occupant Response Procedures, and Incident Management Responsibilities. The program office identifies an individual who works with the Facilities Operations Managers (FOM) to maintain and communicate building emergency plans.

#### **3.13.2 Information Technology (IT) Security Requirements**

Projects hosted at other centers or organizations will use their own institutional requirements and applicable NASA NPRs (NPR 2810.1, etc.).

The LWS program IT system is listed as a subsystem under the GSFC Flight Projects Directorate IT plan, *SC-001-M-GSF-4120 Science Projects (Moderate) Plan 2007-04-04*. This system completed Certification and Accreditation and received full Authorization to Operate in September 2007. The IT security plan covers all of the areas specified in NIST 800-53, "Recommended Security Controls for Federal Information Systems ", and FIPS (Federal Information Processing Standards) 199 "Standards for Security Categorization of Federal Information and Information Systems".

The IT plan covers access, control and authentication; training; auditing; certification, accreditation and assessment; configuration management, contingency planning; incident response; maintenance; media protection; physical and environmental protection; personnel security; risk assessment; system and services acquisition; system and communication protection; and system and information integrity.

#### **3.13.3 Emergency Response Requirements for Facilities**

LWS complies with NASA Continuity of Operations Planning and Procedural Requirements (NPR 1040.1) and Emergency Preparedness Plan for Greenbelt (GPR 8710.2A). The program office identifies an individual (nominally the Program Support Manager) who works with the FOM to maintain and communicate building emergency plans.

### **3.14 EXPORT CONTROL PLAN**

Each project shall prepare and implement an Export Control Plan, as required. There will be no LWS program level Export Control Plan as the deliverables subject to Export Control are provided at the project office Level. Individual LWS project office Export Control Plans will be prepared and implemented at the project office level working with the GSFC Export Control Office. LWS project offices will comply with the export control requirements specified in NPR 2190.1, *NASA Export Control Program*.

Agreements between NASA and other governments or foreign entities are established through Letters of Agreement (LOA) and/or Memorandum of Understanding (MOU). Headquarters leads the establishment of LOAs and MOUs with the support of the program and project offices. The LOAs can either be exclusively for formulation if the dollar value of the contribution is high and then followed by an MOU during implementation or an LOA can cover both formulation and implementation if the dollar value is low. MOUs and LOAs are only established for hardware and software contributions and not for science contributions. The MOUs and LOAs go through the State Department, so they can be used to get Technology Assistance Agreements. When there is no contribution to NASA (for example, when a project contractor wants to purchase components from Europe), the contractor is responsible for getting approval through the State Department for the import. U.S. International Traffic in Arms Regulations (ITAR) and Export Administration Regulation (EAR) laws still apply.

LWS program and project office personnel will receive ITAR training per NPR 2190.1. All international technical exchanges will be approved by the GSFC Export Control Office.

### **3.15 EDUCATION AND PUBLIC OUTREACH PLAN**

The LWS program EPO activities will be conducted at the direction of HQ/SMD/Heliophysics Division, either by the Heliophysics DD or through targeted announcements through the ROSES NRA and/or at the investigation level EPO funding awarded to the investigations through the AO. The projects shall prepare EPO Plans that include investigation level plans submitted in response to the AO by the selected investigators. Project level EPO plans will meet requirements identified by HQ/SMD and may include effort and activities to improve science literacy by engaging the public in understanding the program, its objectives, and benefits. The plans may also include development of educational activities, services, and products that contribute to our Nation's efforts in achieving excellence in science, technology, engineering, and mathematics (STEM) education or to stimulate interest in STEM through program-related public outreach activities.

### **4.0 WAIVERS LOG**

Currently there are no LWS program wide waivers to NPR 7120.5D. Individual projects will submit waivers to be included in the PLRA and maintain a waiver log as part of their Project Plan.

## 5.0 CHANGE LOG

### Change Log

Revision Ltr/ Change No.	Description/ Pages Affected	CCR No.	Date Approved
Initial Release	All	462-05	May 26, 2004
A	Update for 7120.5D requirements	462-19	

## **6.0 APPENDICES**

### **Appendix A Program Level Requirements Appendices (PLRA) Level-1 Requirements – Solar Dynamics Observatory (SDO)**

Refer to document no. 464-PROJ-REQ-0008.

### **Appendix B Program Level Requirements Appendices (PLRA) Level-1 Requirements – Space Environment Testbeds-1 (SET-1)**

Refer to document no. SET-462-RQMT-0003

### **Appendix C Program Level Requirements Appendices (PLRA) Level-1 Requirements – Radiation Belt Storm Probes (RBSP)**

Refer to document no. LWS-RBSP-RQMT-0004

### **Appendix D Acronyms**

AA	Associate Administrator
AO	Announcement of Opportunity
APL	Applied Physics Laboratory
ASM	Acquisition Strategy Meeting
BARREL	Balloon Array for RBSP Relativistic Electron Losses
CCB	Change Control Board
CM	Configuration Management
CMC	Center Management Council
CR	Confirmation Review
DD	Division Director
DoD	Department of Defense

EPO	Education and Public Outreach
FAD	Formulation Authorization Document
FAR	Federal Acquisition Regulation
FOM	Facilities Operations Manager
FY	Fiscal Year
GPR	Goddard Procedural Requirement
GPRA	Government Performance and Results Act
GSFC	Goddard Space Flight Center
HQ	Headquarters
IBPD	Integrated Budget Performance Document
ILWS	International LWS
IT	Information Technology
ITAR	International Traffic in Arms Regulations
ITSP	Ionospheric-Thermospheric Storm Probes
IV&V	Independent Verification & Validation
JHU	Johns Hopkins University
KDP	Key Decision Point
LCC	Life-Cycle Cost
LOA	Letter of Agreement
LWS	Living With a Star

MDR	Mission Definition Review
MOU	Memorandum of Understanding
MSR	Monthly Status Review
NAC	NASA Advisory Council
NASA	National Aeronautics and Space Administration
NPD	NASA Policy Directive
NPR	NASA Procedural Requirements
NRA	NASA Research Announcement
PA	Program Analyst
PBR	President's Budget Request
PCA	Program Commitment Agreement
PE	Program Executive
PI	Principal Investigator
PLRA	Program Level Requirements Appendices
PMC	Program Management Council
PNAR	Preliminary Non-Advocate Review
PS	Program Scientist
RBSP	Radiation Belt Storm Probes
ROSES	Research Opportunities in Earth and Space Sciences
SDO	Solar Dynamics Observatory

SEC	Sun-Earth Connection
SEMP	System Engineering Management Plan
SET	Space Environment Testbeds
SMA	Safety and Mission Assurance
SMD	Science Mission Directorate
SOMD	Science Operations Mission Directorate
SRB	Standing Review Board
STEM	Science, Technology, Engineering and Mathematics
TA	Technical Authority
TR&T	Targeted Research & Technology
UARC	University Affiliated Research Center
U.S.	United States
WBS	Work Breakdown Structure